Remarks

Claims 1 - 3, 5 - 25, 27 - 49 and 51 - 73 are in the application. Claims 71 - 73 have been withdrawn as being directed to a nonelected invention. Accordingly, claims 1 - 3, 5 - 25, 27 - 49 and 51 - 70 are under consideration in the application. Reconsideration of the application is requested, in view of the following Remarks.

Applicants' invention features methods for forming an oxide in a semiconductor device having an ONO structure, by forming and patterning a tunnel oxide layer and a silicon nitride layer, and then concurrently forming a top oxide layer, a buried drain oxide layer, and a gate oxide layer by an in situ steam generation ("ISSG") process. The ISSG process entails heating the substrate to a selected temperature and exposing the patterned structure to an ambient including an oxygen-containing gas and a hydrogen-containing gas. Heating the substrate results in formation of a radical oxidizing agent (such as an oxygen radical) near the surfaces (*i.e.*, "*in situ*") of the patterned structure. As a result the oxidation of the silicon nitride can be effected in a very short time, and at a reduced thermal budget.

The points raised by the Examiner will now be addressed.

<u>Rejections under 35 U.S.C. §103(a)</u>

<u>Yoo in view of APA and Yao</u>:

Claims 1 - 3, 5 - 16, 19, 21, 23 - 25, 27 - 37, 40, 42 - 49, 52 - 61, 64, 66, and 68 - 70 were rejected under 35 U.S.C. §103(a) for obviousness over Yoo *et al.* US 2004/0009642 ("Yoo") in view of Applicants' disclosure in background ("APA") and Yao US 2004/0203253 ("Yao"). These rejections are traversed.

The Examiner stated, as to claims 1, 5 - 8, 16 and 19, that Yoo describes a method for forming an ONO structure, by providing an oxide-nitride film on a surface of a substrate, the oxide-nitride film including a first oxide layer over the substrate and a silicon nitride layer over the first oxide layer; patterning the oxide-nitride film to define bottom oxide and silicon nitride portions of an ONO stack, the bottom oxide and silicon nitride portions having exposed sidewalls and the silicon nitride portion having an exposed surface; and exposing the oxidized sidewalls and the exposed surface to an ambient containing a radical oxidizing agent to form an oxide layer on the expose surface and sidewalls of the patterned silicon nitride portion and on the sidewalls of the

patterned bottom oxide portion. The Examiner acknowledges that Yoo teaches using plasma or high-temperature wet oxidation to generate oxygen radical, and that Yoo does not describe performing an ISSG process to generate oxygen radical under heating temperature in a range about 700 °C to about 1300 °C.

The Examiner then asserted that APA teaches "using ISSG process to grow oxide layer on silicon or silicon nitride" (referring to Applicants' paragraph [0006]), and asserted that "Yao also teaches forming oxide layer on the silicon substrate using ISSG procedure under 800~1000°C" (referring to Yao paragraph [0038]); and the Examiner argued that it would have been obvious "to substitute plasma or high-temperature wet oxidation with ISSG operation as taught by APA/Yao in Yoo's method to generate oxygen radical."

Without conceding that Yoo or Yao is properly applied as prior art, Applicants address the Examiner's points as follows.

Yao does not teach or suggest **patterning an oxide-nitride film to define bottom oxide and silicon nitride portions of an ONO stack on a substrate**, the bottom oxide and silicon nitride portions having **exposed sidewalls**, as recited in Applicants' claim 1. Performing the ISSG operation according to Applicants' invention "by heating the substrate to a selected temperature and **exposing the exposed sidewalls** and the exposed surface ... **to form an oxide layer on the exposed surface and sidewalls of the patterned portion[s]**", as recited in Applicants' claim 1, provides significant advantages, as described in Applicants' specification with reference, for example, to Applicants' Fig. 6 (*see*, *e.g.*, Applicants' paragraphs [0044] - [0045] (avoiding charge leakage from the nitride into the polysilicon).

Armed with Applicants' disclosure, the Examiner picks features from among several publications, while ignoring the teachings of each reference as a whole, in an effort to find the elements of Applicants' invention as claimed. This constitutes impermissible hindsight reconstruction, and these rejections should be withdrawn.

As to claims 2 - 3, 24 - 25 and 48 - 49, the Examiner asserted that Yoo teaches the radical oxidizing agent comprising O* (referring to Yoo paragraph [0026]).

As to claims 9 - 15, 21, 30, 33 - 36, 40, 42 - 46, 54 - 60, 64, 66 and 68 - 70 the Examiner asserted that Yoo "as modified by Yao" describes "heating the substrate to a temperature in a range about 700oC to about 1300oC, expoising the exposed sidewalls and the exposed surface to a mixture of O2 and H2 in a proportion in a range about 0.1% to about 40% at a pressure in a range

about 7.5-14 torr." The Examiner acknowledged that Yoo "as modified by Yao" does not explicitly teach a specific pressure time and flow rate, but argued that "[i]t is an obvious matter of routine experimentation to find the optimal mixture and pressure time ranges." These rejections have the same defects as the rejections of claims 1, 5 - 8, 16 and 19, discussed above: the Examiner has employed Applicants' disclosure of Applicants' invention to inform an effort to find various disparate features of several publications, while ignoring the teachings of each publication as a whole, in an impermissible hindsight reconstruction. These rejections should be withdrawn.

As to claims 23, 27 - 29, 31 - 32, 37, 47, 51 - 53 and 61, the Examiner applied Yoo and Yao as in the rejection of claim 1, "except for an isolation to separate two regions", and then asserted that APA teaches in Fig. 2 forming isolation region (204) in the substrate to separate the substrate", and argued that it would have been obvious to form isolation region in the substrate as taught by APA in the Yoo's method in order to provide separation region in the substrate."

Neither Yoo nor Yao, nor any combination of them, teaches or suggests:

> ...
>
> providing an oxide-nitride film on a surface of a substrate, the substrate having first and second regions defined by an isolation, the oxide-nitride film including a first silicon oxide layer over the substrate and a silicon nitride layer over the first silicon oxide layer;
>
> patterning the oxide-nitride film to expose a surface of the substrate in the second region and to define bottom oxide and silicon nitride portions of an ONO stack in the first region of the substrate, the bottom oxide portion and silicon nitride portions having exposed sidewalls and the silicon nitride portion having an exposed surface, and
>
> performing a ISSG operation ... to form concurrently a second oxide layer on the exposed surface and sidewalls of the patterned silicon nitride portion and a gate oxide layer on the substrate surface in the second region ...

as recited in Applicants' claim 23; and the rejections of claim 23 and of claims depending therefrom should be withdrawn.

<u>Yoo in view of APA and Yao and further in view of Ikakura</u>:

Claims 17 - 18, 20, 22, 38 - 39, 41, 62 - 63, 65 and 67 were rejected under 35 U.S.C. §103(a) for obviousness over Yoo in view of APA and Yao and further in view of Ikakura *et al.* U.S. 6,255,230 ("Ikakura"). These rejections are traversed.

The Examiner acknowledged that Yoo does "not explicitly teach flowing the mixture of O_2 and H_2 further comprises flowing N_2 as a carrier gas." Ikakura was relied upon as teaching N_2 gas as a carrier gas. The Examiner argued that it would have been obvious to use N_2 as a carrier gas "since the carrier gas may help flowing an oxygen radical hence improving the oxide layer quality." The rejection is traversed, in view of the arguments regarding Yoo, Yao, and APA, *supra.*, and in view of the fact that any "help" in "flowing an oxygen radical" is not relevant to Applicants' invention. According to the *in situ* process employed in Applicants' invention, the oxygen radical is formed by reaction of the H_2 and O_2 at the wafer surface (*see*, *e.g.*, Applicants' paragraph [0030]), so that it is not necessary to "flow" the oxygen radical. No combination of Ikakura with Yoo and Yao and APA describes or suggests Applicants' claimed combination including an *in situ* ISSG oxidation to form the oxide layer concurrently on the upper surface and sidewalls of the SiN layer, a buried diffusion in the substrate, and a gate oxide layer on a MOS region of the substrate.

Accordingly, the rejection of claims 17 - 18, 20, 22, 38 - 39, 41, 62 - 63, 65 and 67 should be withdrawn.

In view of the foregoing, all the claims now under consideration in the application -- namely, claims 1 - 3, 5 - 25, 27 - 49, and 51 - 70 -- are in condition for allowance; and action to that effect is respectfully requested.

This response is accompanied by a Notice of Appeal and a fee or fee authorization therefor.

This Response is being filed within the third month following the shortened statutory period set by the Examiner for response to the Office action and, accordingly, it is accompanied by a petition for three months' extension of time and a fee or fee authorization therefor. In the event the Examiner may determine that additional fee[s] be required in connection with the filing of this paper, petition is hereby made therefor, and the Commissioner is authorized to charge such fee (or to credit any overpayment) to Deposit Account No. 50-0869 (MXIC 1516-1).

If the Examiner determines that a conference would facilitate prosecution of this application, the Examiner is invited to telephone Applicants' representative, undersigned, at the telephone number set out below.

Respectfully submitted,

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